

PennDOT Statewide Bicycle And Pedestrian Master Plan

submitted to

**Commonwealth of Pennsylvania
Department of Transportation**

submitted by

The RBA Group

Bicycle Federation of America
(In association with Greenways Incorporated)

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PREFACE

The Pennsylvania Department of Transportation's Statewide Bicycle and Pedestrian Master Plan is a compilation of five documents, each with a specific purpose toward integration of bicycles and pedestrians into the State's Transportation System.

These documents include:

- **Executive Summary**
- **Statewide Bicycle and Pedestrian Master Plan**
- **Bicycle Planning and Design Guidelines**
- **Pedestrian Planning and Design Guidelines**
- **Community Design Systems**



The "Executive Summary" highlights the key elements of the policy document and is intended as an informational resource for a broad range of users. The "Master Plan" is a policy document and discusses the vision, goals, issues, actions and implementation strategies necessary to integrate bicycles and pedestrians into the transportation system. It supersedes the 1976 Bicycling in Pennsylvania Plan. There are two documents which supplement the policy plan by providing planning and design guidelines for pedestrian and bicycle compatible roadways and facilities. These are the "Pedestrian Planning and Design Guidelines" and "Bicycle Planning and Design Guidelines." In addition, the "Community Design Systems" document has been developed to address walking and bicycling issues at the local level for the various types of communities and places in Pennsylvania.

Pedestrian Planning and Design Guidelines

This document, Pedestrian Planning and Design Guidelines, acts as a guide for PennDOT and for local governments undertaking pedestrian facility planning and design. The guidelines provide technical assistance for creating pedestrian compatible roadways and providing appropriate facilities, which will make the current transportation system accessible to pedestrians. Pedestrian Guidelines have been developed to be consistent with the Manual on Uniform Traffic Control Devices and the Americans with Disabilities Act.

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**And all those who participated in the
Statewide Public Meetings and Workshops.**

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1.0 Introduction

1.1 Purpose

The purpose of this document is to guide local communities in improving conditions for pedestrians. Included are policy recommendations for local governments, pedestrian planning techniques, and pedestrian facility design guidelines. This document is intended for both internal use within PennDOT, and as a guideline for local governments undertaking pedestrian facility planning and design.

At the time of this writing, there is no comprehensive national safety standard for pedestrian facilities, such as there is for bicycle facilities. The Manual on Uniform Traffic Control Devices (MUTCD), the Americans With Disabilities Act and the Proposed Recommended Practice of the Institute of Transportation Engineers entitled Design and Safety of Pedestrian Facilities address some aspects of pedestrian safety, and should be used as supplements to this document. The guidelines herein are consistent with these documents.

The reader is also instructed to reference PennDOT's Strike-off Letter of April 14, 1993 (subject: Bicycle/Pedestrian Strategies) for departmental policies pertaining to pedestrian facility development, and the 1990 edition of PennDOT's Guidelines for the Design of Local Roads and Streets, Section 3.4E.

These guidelines provide a number of techniques to improve pedestrian mobility — none of which may be sufficient if used alone.

Successful pedestrian spaces combine a variety of elements to form a safe and inviting atmosphere. A narrow sidewalk next to a busy arterial road does little to invite pedestrian activity - although sidewalks are a good place to start. A person's decision to walk is also a factor of distance, convenience, adequate buffer from traffic, the perceived danger of intersections, and the quality of the walking environment.

Improving conditions for pedestrians requires long term commitments and better cooperation between the state and local governments as well as private landowners. By changing our pedestrian policies today, a Pennsylvanian in the year 2010 might describe her trip to work like this:

I regularly walk to work from my home on the south side of town. It's not too far to travel, since I live just under a mile from the office. I live in an area of mixed residential homes, business and commercial areas, and I can walk to just about anywhere I want to go in a matter of minutes.

On the way to work this morning, I took Maple Street, which has nice, wide, tree-lined sidewalks. When I came to the first corner, a car was making a right turn — but immediately stopped to wait for me to cross. That's what I like about this town - motorists seem to respect the rights of pedestrians.

On the next block, I stopped at Marge's Cafe for a cup of coffee, and sat under an awning at a sidewalk table for a couple of minutes to drink it.

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2.1 *Pedestrian-Oriented Land Use Policies*

The most important measure to encourage walking is to bring goods and services within walking distance of where people live and work. A recent study for the Federal Highway Administration confirms this: 33% of survey respondents cited distance as the primary reason for not walking. Further studies have shown that most people are willing to walk for 20 minutes to reach utilitarian destinations, or about 2 kilometers (1.25 miles).

In light of these findings, the most conducive land use for pedestrian activity is a high density mix of jobs, housing and retail. Studies have also shown that more people walk in areas that achieve high densities of *either* housing or employment, with lower densities of other land uses. One study of the Puget Sound Region in Washington defines high density as 50 to 75 employees per hectare (acre), or 9 to 18 residents per hectare (acre).

The establishment of pedestrian-oriented policies often begins with a community “visioning” exercise as described in the following inset.

A Community Visioning Exercise

Changes to local zoning ordinances to encourage higher density pedestrian-oriented development are likely to be controversial. A public education program can help to gain popular support for higher density and mixed use development.

One very successful educational tool was used in Portland, Oregon. The City conducted a well-publicized visual preference survey, allowing local citizens to establish a vision for their ideal community environment by comparing photographs of different styles of development. This survey not only helped local residents understand what high density development looks like, but also proved that this was a preferred style of development when compared to suburban sprawl.

2.2 *Removing Barriers to Walking Through Better Planning*

Pedestrian travel is often an afterthought in the development process. The results are impassable barriers to pedestrian travel, both within and between developments. Local zoning ordinances can be amended to require more attention to the needs of pedestrians. Examples include the following:

- Internal Bicycle and Pedestrian Circulation for Development Sites

Adequate provisions should be made for bicycle and pedestrian circulation between buildings and related uses on development sites (ADA also contains regulations for on-site circulation).

I continued on my journey, stopping once more to drop off mail at the post office and to pick up my drycleaning. I soon came to the only large, busy road that I have to cross to get to work. I pressed the pedestrian signal button, and waited briefly for my turn to cross, along with 5 or 6 other pedestrians. The walk signal is timed so that we had plenty of time to make it across, even the elderly man who was a little slower than the rest of us.

Just across the road, I intersect with the "South-East Trail", as everyone calls it. It was built by the City as part of an entire network of off-road paths. This trail offers me a short-cut to work by linking to the back side of the office park, through a beautiful open space area. I can rest assured that although I sometimes work late, these paths will be well-lit tonight on my way back home (and usually full of people out for an evening stroll!).

Upon arriving at work, I felt refreshed and alert from my walk. Even though I enjoy walking in, it doesn't hurt that the company gives a small reimbursement to employees who walk or bike to work. It's not much, but it buys me a great lunch on Fridays in the cafe down the street . . .

Transportation planning in the past has responded to the demand to improve the efficiency of automobile travel. In the past, traffic engineers and transportation planners have had few opportunities to provide input into the land use policies that created the need for wider roadways and increased automobile efficiency.

The recommendations within this report represent guidance for transportation engineers, planners, architects and land developers throughout Pennsylvania.

PennDOT will provide assistance with pedestrian facility development, where appropriate. Reference DOT's April 14, 1993 Strike-off Letter (subject: Bicycle/Pedestrian Strategies) for more information.

2.0 The Elements of Good Pedestrian Planning

Good pedestrian planning begins with basic policy statements made by local governments. Comprehensive land use plans and transportation master plans should recognize and encourage walking as an alternative mode of transportation, and should provide a clear mandate to improve pedestrian mobility throughout the community.

In order to make pedestrian travel successful, a community must not only provide facilities but also ensure that people can walk to their destination in a reasonable amount of time. This represents a major problem in many Pennsylvanian communities today - single-use zoning has created distances that are difficult to walk. The potential to increase pedestrian transportation is directly related to current spatial relationships between land uses and better local land use planning decisions in the future.

Code amendments will be necessary in all cases where local zoning ordinances are in direct conflict with pedestrian-oriented transportation and development. The following are specific recommendations for pedestrian-oriented policies.

Policy Enforcement Through the Site Plan Review Process

Land developers should be asked to submit a "Pedestrian and Bicycle Mobility Plan" early during the site plan review process. This plan should provide an inventory of all existing and proposed land uses adjacent to the site, and illustrate a logical circulation plan for pedestrians and bicycles within the development and between adjacent land uses. The questions below can help architects and engineers to create site plans that are sensitive to the needs of pedestrians.

Pedestrian Site Plan Checklist

Overall Pedestrian System

- Does the plan meet or exceed ADA standards?
- Are utilitarian paths direct? Do they provide for connections to pedestrian magnets nearby? Can pedestrians take advantage of "shortcut paths" that encourage walking instead of driving?
- Does the pedestrian system consider the type and probable location of future development on adjacent or nearby parcels of land? Is there flexibility to provide direct connections to adjacent parcels, should that be desired in the future?
- Are building entrance areas convenient to the pedestrian? Are they clearly evident through either design features, topography, signing or marking?
- Are walkways along the street buffered from traffic as much as possible?
- Are both utilitarian and recreational walking considered in the plan?
- Do pathways take advantage of unique or scenic site features where possible?

Safety and Security

- Are crossings of wide expanses of parking lot held to a minimum?
- Are pathways generally visible from nearby buildings and free from dark, narrow passageways?
- Is adequate pedestrian-scale lighting provided for nighttime security?
- Are sight lines at intersections adequate for pedestrian visibility? Are pedestrians able to see on-coming traffic, given typical speeds?
- Do pathways lead to road crossing points with the least conflict?
- In general, are pedestrian/vehicle conflict points kept to a minimum?
- Are pedestrians given adequate time to cross the road at intersections?

Walking Surfaces and Amenities

- Are walking areas scaled to the pedestrian?
- Are the walking surfaces skid-resistant and sloped for drainage?
- Are provisions made for curb ramps and are they properly designed?

Adapted from: Planning and Implementing Pedestrian Facilities in Suburban and Developing Rural Areas, TRB Report 294A

2.3 Commercial and Office Sites that Encourage Walking

The physical layout of a development can often make the difference in a person's choice to walk. Careful attention should be given to the location of buildings as well as the configuration of parking lots. Several provisions can ensure a better walking environment in commercial and office developments:

- Building Setbacks

Buildings should not be separated from the street by parking lots - this discourages pedestrian access and primarily serves those who arrive by automobile. A *maximum* setback requirement of 4.5 meters (15 feet), particularly for transit streets, can help to encourage pedestrian

- Subdivision Layout

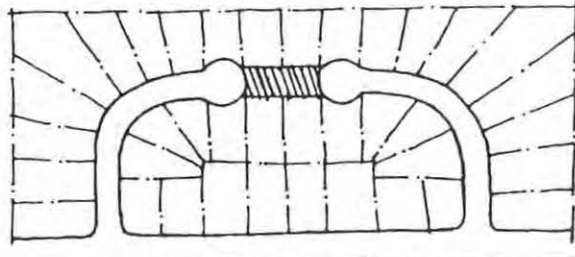
Residential subdivision layout (including Planned Unit Developments) should provide safe, convenient and direct bicycle and pedestrian access to nearby* and adjacent residential areas, transit stops, and neighborhood activity centers such as schools, parks, commercial and industrial areas, and office parks.

* As used in this context, the word "nearby" should be interpreted to mean uses within 0.4 kilometers (1/4 mile) for pedestrian travel and 3.2 kilometers (2 miles) for bicycle travel, at a minimum.

- Cul-de-sacs

Cul-de-sacs have proven to be effective in restricting automobile through traffic, however they also restrict bicycle and pedestrian mobility unless public accessways are provided to connect the cul-de-sac with adjacent streets. Trail connections between cul-de-sacs and adjacent streets should be provided wherever possible to improve access for bicycles and pedestrians as shown in Figure 1.

Figure 1
Pedestrian Connections



Source: *Accommodating the Pedestrian*, Untermann, 1984

- Future Extensions of Streets

Where subdivisions are located adjacent to land likely to be divided in the future, streets, bicycle paths and pedestrian accessways should continue through to the boundary lines of the area.

- Inclusion of Bicycle and Pedestrian Facilities in Piecemeal Development

An ordinance can be adopted to ensure that pedestrian and bicycle facilities are included in projects that occur in a piecemeal fashion. For projects in which only *part* of the land owned by the applicant is proposed for development, a plan showing the tentative locations of streets, bicycle facilities and public accessways should be submitted for the entirety of the land owned.

- Compliance with Design Standards

Bicycle and pedestrian facilities should be designed per local and statewide design guidelines.

- Pedestrian and Bicycle Mobility Plan

During the site plan review process, this plan can be required for new developments and substantial redevelopment projects, to assure adequate consideration of non-motorized needs. A checklist as shown in the following inset may be used to define the scope of this plan.

- On-site Walkways

For developments with multiple buildings, all building entrances on the site should be connected by walkways to encourage walking between buildings and to provide a safe means of travel for pedestrians. Sidewalks between the building edge and parking lots should allow pedestrians safe and convenient access to building entrances without having to walk within driving aisles of parking lots.

- Pedestrian Access Between Adjacent Developments

Sidewalks should connect uses on the development site to adjacent activity centers to encourage walking instead of driving between uses. Barriers such as fences or vegetation should not be placed to hinder access between developments.

- Lighting

Pedestrian-scale lighting should be designed to light the walkway, instead of the parking lot, to enhance pedestrian safety. (This is in addition to required lighting of the parking lot.)

- Improvements Between the Building and the Street

Design elements in the area between the building and the street are critical to successful pedestrian spaces. The streetscape should provide visual interest for the pedestrian. The area should be landscaped and/or paved with a hard surface suitable for walking. The area should provide amenities for pedestrians such as seating areas, drinking fountains, and/or other design elements such as public art, planters and kiosks. See Figure 4.

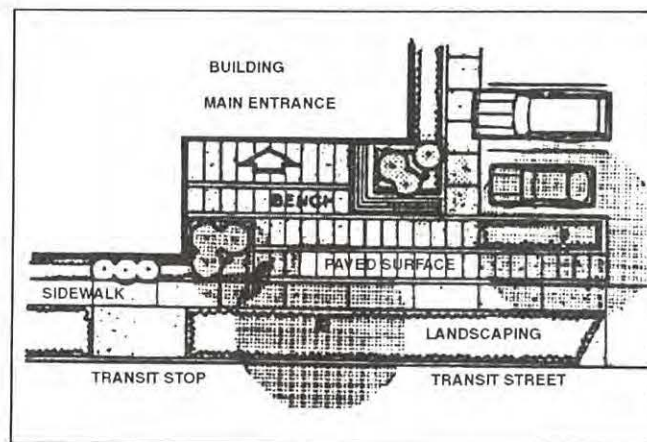


Figure 4:
Streetscape

Source: Eugene Transportation Planning Rule, Oregon, 1993.

- Lot Coverage

Zoning codes should be amended to raise the allowable lot coverage along transit corridors to encourage intensification of uses and more efficient use of land in these areas.

- Parking Reductions

Parking codes should be modified to allow for a “reduced parking option” for developments that are located in transit corridors and which provide facilities that encourage bicycling and walking.

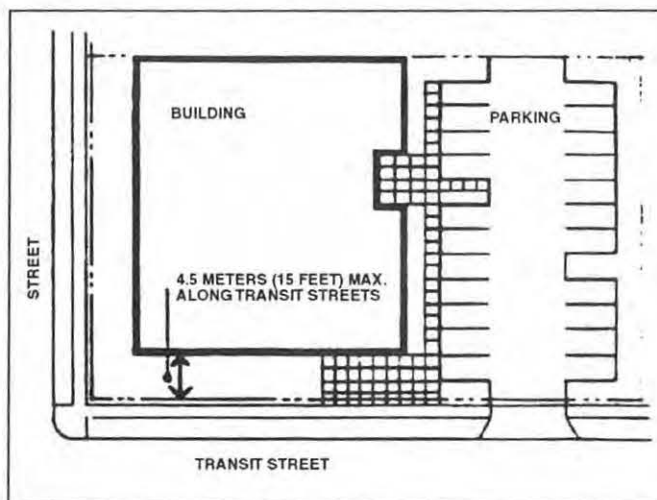
- Parking Lot Design

Parking lots with fifty spaces or more should be divided into separate areas with walkways and

activity. Parking, driving and maneuvering areas should certainly not be located between the main building entrance and a street served by transit. Parking lots should be located on the side and rear yards of the property.

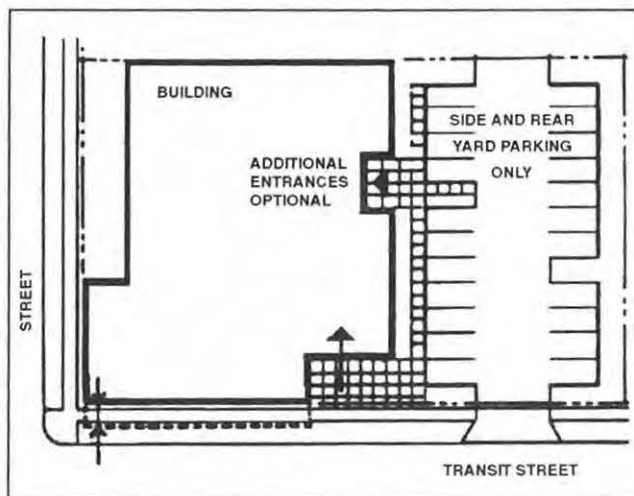
For developments with multiple buildings, direct pedestrian access to public transit should be provided by clustering buildings near transit stops as shown in Figures 2 and 3.

Figure 2:
Building Setbacks



Source: Eugene Transportation Planning Rule, Oregon, 1993.

Figure 3:
Pedestrian Entrances



Source: Eugene Transportation Planning Rule, Oregon, 1993.

- **Building Orientation and Facades**

Main building entrances should be oriented on the facade facing a transit street. Entrances and paved walkways should lead directly to a transit stop. Visual stimulation is very important to pedestrians - long, blank walls with no openings onto the street discourage pedestrian activity. Building facades should maintain continuity of design elements such as windows, entries, store fronts, roof lines, materials, pedestrian spaces and amenities, and landscaping. Parking garages on streets with transit service should have ground floor street frontage developed for office, retail or other pedestrian-oriented uses.

- The streets are relatively narrow, in order to discourage high speed automobile traffic. Streetscapes should be well-defined by buildings and trees along them.
- On-street parking is permitted and provides an adequate supply of spaces. The cars act as additional buffers in the form of large blocks of steel between pedestrians on sidewalks and moving vehicles on the adjacent street. They also serve to slow down the passing traffic, helping to balance the overall use of the street.
- Bicycles are considered an integral part of the transportation mode mix, and the design of the streets includes appropriate facilities for them.
- The buildings are generally limited in size, and building uses are often interspersed; that is, small houses, large houses, outbuildings, small apartment buildings, corner stores, restaurants, and offices are compatible in size and placed in close proximity.
- In addition to streets, there are squares that form public commons, around which are larger shops and offices, as well as apartments.
- Civic buildings (meeting halls, theaters, churches, clubs, museums, etc.) are often placed along the squares and sometimes at the termination of streets so that important buildings receive important locations.

***Note:** List taken from *ITE Journal*, January 1992 edition, p. 17-18.



Figure 5:
Tree Lined
Street

Source: Greenways Incorporated

2.5 *City-Wide Pedestrian Master Planning*

It is important for local governments to assess the current condition of the pedestrian transportation system and develop a master plan for future pedestrian improvements. This process also can enable local planners to work better with private developers to make logical connections between public and private facilities. A city-wide pedestrian master plan may have several elements:

landscaped areas in between that are at least 3 meters (10 feet) in width. Pedestrian paths should be designed with minimal direct contact with traffic. Where pedestrian paths cross the traffic stream, raised speed tables that slow cars, while providing an elevated pedestrian walkway should be provided. Additional recommendations for pedestrian-oriented parking lots:

- a. Location
Keep parking on one or two sides of shopping centers, oriented away from the side that will generate the most pedestrian access. This pedestrian access point could be an office park, out parcel shopping or restaurant, or a residential area.
- b. Direct Pedestrian Paths
Provide a direct pedestrian path from parking lots and parking decks to the buildings they serve. Clearly delineate this path with striping, different paving materials, or by situating the path through the center of a series of strategically placed parking islands.
- c. Use of Landscaping
Landscaping can be used to channelize and organize the traffic flow in parking lots, as well as to provide pedestrian refuge areas. Avoid open parking lots that allow cars to move in any direction.

2.4 Residential Communities that Encourage Walking

Most modern residential communities in Pennsylvania do not encourage walking. This was not always the case: pre World War II era neighborhoods were oriented to the streetcar and to the pedestrians they attracted. Homes were closer together, front yards were short, streets were narrower, and sidewalks were a standard feature. The following description provides an excellent overview of the situation in suburban Pennsylvania:

*Over the last 40 years, as automobiles replaced street cars, the need for locating houses close to the streetcar stop disappeared. Retail business concentrated near the street car stop began to spread out randomly along the principal roads, as did residential subdivisions and apartment complexes . . . Curbs and sidewalks, symbols of a pedestrian and street-car-oriented world, became expensive and unnecessary features in this new, low density environment. House lots became wider to accommodate garages, and houses themselves were set back from the street to reduce the noise and nuisance of passing cars.**

*Excerpt from Linking Land Use and Transportation, Untermann, 1991.

The character of suburban community design must be modified if pedestrian transportation is ever to become a viable option. One solution is to develop communities that are oriented to a more balanced transportation system supporting automobiles, bicycles, transit and pedestrians. A multi-modal community can include the following aspects:*

- A neighborhood center (providing commercial and office uses) is located within 5 minutes walking distance, roughly 0.4 kilometer (quarter mile) radius for the majority of residents in the neighborhood.
- The streets are laid out in well-connected patterns, at a pedestrian scale, so that there are alternative automobile and pedestrian routes to every destination. See Figure 5.
- The streets are treated as complex public spaces, containing traffic and parking, and they are an integral part of the visual panorama consisting of the trees, sidewalks, and buildings that front on them.

Sidewalks needed on collector streets	10
Sidewalks needed on busy local streets**	5

*Does not include limited access roadways.

**Local streets with 1000 or more cars per day.

Step 3: Identify Major Pedestrian Attractors

In Step 3, features that attract pedestrians should be identified for each proposed sidewalk route. Points are assigned based on the amount of walking that could be generated by major pedestrian attractors. There are five categories of attractors:

School Location

Sidewalk needs within approximately 0.4 kilometers (one-quarter mile) of a school should be given 5 priority points. Although children may often walk a mile or more to school, they are more concentrated within the 0.4 kilometer (quarter mile) radius.

Typical School Walking Route

Streets that are located within 1.6 kilometers (one mile) of a school, and which provide a direct route and serve as a pedestrian collector for other streets, should be given an additional 5 priority points. This rating should entail a systematic analysis based on designated school walking routes, city street maps, and on-site observations.

Parks and Recreation

Sidewalk needs within 0.4 kilometers (one-quarter mile) of any type of public park or recreation facility should be assigned 10 priority points. Facilities included in this category are neighborhood parks, tot lots, community centers, swimming pools, ball fields, regional parks, major off-street multi-use trails, etc.

Commercial Facilities

Sidewalk needs within 450 meters (1500 feet) of commercial areas should be assigned 10 priority points. This should be based on actual and proposed commercial facilities that could potentially attract pedestrians, particularly shopping centers with multiple vendors.

Bus Routes

Sidewalk needs on streets which serve bus routes should be assigned 10 priority points. Proximity to bus stops should also be a consideration.

NOTE: If one sidewalk would serve several pedestrian attractors under one category, then the points given for that category should be increased. For example, if one sidewalk would serve two shopping centers, the sidewalk should be given 20 priority points.

Step 4: Compute Total Priority Points

By adding the street classification points to the pedestrian attractor points, a total priority value can be computed. This system will enable local and regional governments to rank sidewalk projects in order of importance.

Street Type	Basic Points	Ped Attractor Points	Total Priority Points (Min)	Total Priority Points (Max)
Major arterial	20	0 - 40	20	60
Minor arterial	15	0 - 40	15	55
Collector street	10	0 - 40	10	50
Busy local street	5	0 - 40	5	45

*Note: This exercise was adapted from City of Eugene Sidewalk Program.

- Sidewalk Inventory/Improvements Plan

A inventory should be conducted to identify locations of existing sidewalks and those in need of repair. A plan for sidewalk improvements/new sidewalk construction should be developed, with a phased implementation schedule. A priority ranking system for sidewalk construction can be used, as described in the following section.

- General Pedestrian Safety Improvements Plan

This plan should identify streetscape improvement projects, particularly in downtown areas and near major pedestrian attractors. This plan should include a comprehensive study of pedestrian needs at local street intersections. The plan can also include measures to reduce motor vehicle speeds where appropriate.

- Greenway Plan

This plan should identify corridors for future trails that are separated from the street system. Such corridors may include streams and rivers, abandoned railroad rights-of-way, active utility rights-of-way, and public or private open space lands. The plan should focus on providing short-cuts for pedestrians to nearby destination points, and should be designed for dual use with cyclists.

A master pedestrian plan is also an excellent way to bring pedestrian issues into the public forum. The planning process should include opportunities for local citizens to voice their concerns. It is particularly important to solicit the involvement of the less affluent portions of town, where lower-income residents are often pedestrians out of necessity. They can provide valuable insights regarding barriers to pedestrian travel.

A pedestrian master planning project also provides the opportunity to discuss and implement policy changes. Visual preference surveys can be conducted at this time, to gain feedback on preferred development and transportation styles.

2.6 *Sidewalk Priority Ranking System**

A program for prioritizing sidewalk projects enables local governments to determine areas with the most critical need for sidewalks. The Sidewalk Priority Ranking System described below allows planners to objectively analyze sidewalk improvement requests from local citizens. Local governments can consider this process to develop a prioritized list of projects.

Step 1: Inventory Existing Sidewalks

Sidewalk information should be obtained for every parcel of land adjacent to a public street, and this information should be mapped on a Geographic Information System (GIS) system (if available). Additional mapping overlays should address locational features that are relevant to pedestrian mobility, such as major destination points (schools, parks, commercial areas, etc.), bus routes, street classifications, and sidewalks in need of repair. All areas lacking sidewalks or needing sidewalk improvements should be identified, and compiled in a listing.

Step 2: Assign Points

Since this exercise is intended to identify those areas with the most critical need for sidewalks, the busiest urban roadways are included in this classification. Priority points are assigned according to roadway type, as follows:

<u>Street Classification</u>	<u>Points</u>
Sidewalks needed on major arterials*	20
Sidewalks needed on minor arterials	15

In general, roadway width in downtown areas should be kept to a minimum, in order to provide a balance between space allocated for motor vehicle traffic versus sidewalk space. Narrower corner radii can be used to reduce crossing distances for pedestrians at intersections, as well as to slow the speed of turning vehicles.

Businesses in downtown areas should be encouraged to expand out into the pedestrian area with canopies, cafes and planters (without impeding through-access). Store and office fronts should be re-designed to appeal to the pedestrian, with windows and awnings: long expanses of blank, windowless walls should be avoided. Parking garages should have the ground floor developed for retail and office space.

3.2 *Pedestrianizing Existing Retail/Office Developments*

Entrances to many commercial and retail centers in Pennsylvania are mainly oriented to automobile travel. Bicycle and pedestrian access to storefronts is not only difficult and awkward, but often unsafe. For the purposes of this discussion, a shopping center is used as an example of how to retrofit existing developments to accommodate pedestrians. The same principles apply to other types of development such as office complexes and multi-family housing.

An average shopping center or “strip mall” is separated from the roadway by a wide parking lot that averages between 90 to 150 meters (300 to 500 feet) in depth. There are often no pathways linking store entrances to the sidewalks along the street, and sometimes there are no sidewalks on the street to which to link. Parking lots with multiple entryways allow traffic to circulate in different directions, creating hazards and confusion for walkers and cyclists. Drive-throughs at banks and fast-food restaurants in out-parcel developments add to pedestrian safety problems and encourage people to drive between different destinations on the site. See Figure 7.



Figure 7:
**Expanse of
Parking Lot**

Source: Greenways Incorporated

3.0 Retrofitting Land Uses to Serve Pedestrians

Since the 1940's, development in Pennsylvania has been shaped by the predominance of automobile transportation. As a result, urban areas across the state are becoming increasingly unpleasant, especially for the pedestrian. Urban smog has begun to spread into suburban areas, roadways are clogged with traffic, and people perceive that they have no realistic alternatives to automobile travel.

New land use policies will help to remedy *future development* in Pennsylvania, but will not solve the immediate problems in urban and suburban areas, where *existing land uses* do not accommodate - much less encourage - walking or bicycling.

This section focuses on methods of retrofitting existing developments to improve pedestrian mobility. Some of the suggestions are site specific - based on a typical redevelopment effort.

3.1 Downtown Redevelopment

In many Pennsylvania cities and towns, the downtown area still serves as an important business and commerce center. The higher density of the downtown represents an important opportunity, since it is easier to walk short distances. Streetscape improvement projects can help to make the downtown a more attractive destination for pedestrians, and will also improve the sales revenues for downtown businesses.

Streetscape improvements should focus on creating a pleasant walking environment that provides the pedestrian with a sense of separation from traffic. Elements may include wide sidewalks with textured pavement, awnings, pedestrian-scale lighting and signage, benches and trash cans, bicycle parking, public art, intersections with pedestrian signals and textured crosswalks (raised slightly from surrounding street), shade trees and landscaping. In some circumstances, parallel parking can help to buffer the sidewalk from adjacent traffic. See Figure 6.

Figure 6:
Downtown Streetscapes



Source: Greenways Incorporated

Improve Pedestrian Circulation and Safety Measures on Site

- Connect all buildings on site to each other via attractive pedestrian walkways, with landscaping and pedestrian-scale lighting. Provide covered walkways where possible.
- Minimize pedestrian/auto conflicts by consolidating auto entrances into parking lots.
- Separate roads and parking lots from pedestrian pathways through the use of grade changes.
- Implement safety measures at pedestrian crossings such as raised speed tables/pedestrian crossings, differentiated pavement texture at crossings, warning signage, tight corner radii, and other measures (see section of this report on Pedestrian-Cautious Roadways).

3.3 *Retrofitting Suburban Residential Neighborhoods*

Suburban areas are the most difficult land use to retrofit for pedestrians, mainly due to their sprawling character. Pedestrian travel distances are excessive, because the nearest destinations are usually more than a 20-minute walk. In some cases, distances that are longer via the roadway can be reduced by providing “short-cuts” for pedestrians and eliminating barriers between developments. The following recommendations address these conditions, as well as the need for more pedestrian facilities.

- Bring Destinations Closer to Home

More pedestrian trips can be encouraged by changing the single-use character of suburban development. By allowing mixed use development, unused parcels of land within suburban neighborhoods can be developed into close-to-home destinations such as shopping/community centers, parks, schools and transit facilities.

- Encourage Denser Development

Suburban home owners should be encouraged to develop garage cottages or backyard “granny flats” for rent. This also brings affordable housing to neighborhoods in a way that will be less controversial than developing an entire tract of land for low-income housing.

- Provide Sidewalks and Street Trees

Street trees are essential to successful pedestrian spaces: they create a sense of enclosure and provide shade. They may, however, create a safety concern on higher speed roadways, 55 km/h (35 mph) or greater. Residential streets should have sidewalks on both sides, and street trees that will grow to a sufficient size to shelter the sidewalks. Wider sidewalks should be provided on routes that lead to pedestrian magnets such as parks, shopping centers, schools and transit stops.

- Reduce the Speed of Automobile Traffic

High speed traffic on residential streets can be dangerous for pedestrians and cyclists. Residential roadway design guidelines can be revised to encourage slower speeds. There are a variety of techniques to decrease traffic speed and discourage cut-throughs, including narrower lane widths, speed tables, small traffic circles or roundabouts, and interrupted sight lines so that motorists cannot pick up speed on long, straight segments of roadways. (Refer to Section 7.1 of the Pedestrian and Design Guidelines)

- Provide Off-Road Internal Pathway Systems

Neighborhood greenways not only provide a place for recreation, but also a short cut to nearby destinations. The traditional “alleyway” can also serve pedestrians. Alleyways are shared residential driveways that lead to the rear sides of homes. They also improve conditions for pedestrians along the streets in front of homes, since the sidewalks are not interrupted by driveways.

Storefronts do little to entice walking. They are often barren and devoid of windows and are therefore visually unappealing at a pedestrian scale. If they exist, walkways between stores are often narrow and uncovered, and pedestrian amenities such as benches are rare. Pedestrian connections between developments are not provided encouraging shoppers to get back in their automobiles to access adjacent developments.

Although the problems with shopping centers are numerous, they can be redeveloped to better serve pedestrians. As older shopping centers undergo renovations, they should be redesigned to serve customers who arrive via transit, automobile, bicycle and on foot as shown in Figure 8. Specific methods include:

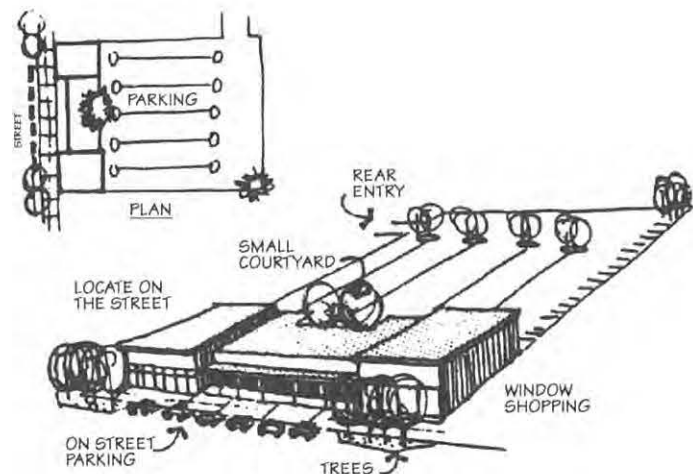
Maximize Pedestrian and Transit Access to the Site from Adjacent Land Uses

- Provide comfortable transit stops and shelters with pedestrian connections to the main buildings. Transit stops and pedestrian drop-offs should be located within a reasonable proximity to building entrances - preferably no more than 225 meters (750 feet), and ideally much closer than that.
- Provide attractive pedestrian walkways between the stores and the adjacent sites.
- Ensure that fencing and landscaping does not create barriers to pedestrian mobility.

Improve the Layout of Buildings and Parking Lots

- Increase the density of existing sites by adding new retail buildings in the existing parking lots, with offices or multi-family housing around the perimeter of the site.
- Locate parking lots on the sides and to the rear of buildings, with major retail being situated closer to the street.
- Rework entrances and orient buildings toward pedestrian and transit facilities instead of parking lots.
- Arrange buildings on site to reduce walking distance between each building and between the nearest transit facility.
- Provide covered walkways around and between buildings, if possible.

Figure 8:
Shopping/Commercial
Center Guidelines



Source: *Accommodating the Pedestrian*, Untermann, 1984

Figure 9:
**Guidelines for
Installing Sidewalks**

Types of areas (land-use, roadway functional classification, or dwelling units)	Where do you need sidewalks . . .	
	. . . with new urban and suburban streets?	. . . with existing urban and suburban streets?
Commercial and industrial — all streets.	On both sides of these streets.	On both sides of these streets — make every effort to add them and to complete missing links.
Residential — major arterials.	On both sides of these streets.	On both sides of these streets.
Residential — collectors.	On both sides of these streets.	For multi-family dwelling — on both sides of these streets. For single-family dwellings — on at least one side of these streets.
Residential — local streets with more than 4 units per acre.	On both sides of these streets.	Preferred on both sides, but required for at least one side.
Residential — local streets with 1-4 units per acre.	Required on one side, but preferred on both sides.	Preferred on at least one side. At least 4-foot shoulder required on both sides.
Residential — local streets with less than 1 unit per acre.	On one side of these streets preferred, but shoulder on both sides required.	Preferred on at least one side. At least 4-foot shoulder required on both sides.

Notes:

- 1 You must have a sidewalk on at least one side of any local street that is within two blocks of a school and that is a walking route to that school.
- 2 You may omit a sidewalk on one side of any new street when that side of the street clearly cannot be developed and when there are no uses or planned uses for that side of the street that would encourage people to walk there.
- 3 When a main road has a service road, you may eliminate the sidewalk next to a main road if you replace it with a sidewalk on the far side of the service road.
- 4 When you have a rural road that is not likely to serve development, you must provide a shoulder at least 4 feet in width. If the road serves as a primary highway, the shoulder should be 5 feet wide. The shoulder should be made of a material that provides a stable, mud-free walking surface.

Source: Walk Alert: National Pedestrian Program Safety Guide, FHWA.

4.2 Sidewalk Obstacles

Street furniture and utility poles create obstacles to pedestrian travel when located directly on the sidewalk. At the very minimum there should be 915 millimeters (36 inches) of sidewalk width to allow wheelchairs to pass. Where possible, utilities should be relocated so as not to block the sidewalk. Benches should never be sited directly on the sidewalk, but set back at least 0.9 meters (3 feet).

The design of new intersections or re-design of existing intersections presents an opportunity to improve pedestrian circulation. Street furniture located near intersections can block sight lines. In general, the designer should consider the impact on sight distance for all features located in the vicinity of roadway intersections.

- Provide “Pocket” Parks and Community Green Space

Small community parks and open spaces provide an area for close-to-home recreation as well as destination points for cyclists and walkers.

4.0 Sidewalk Design Principles

Sidewalks are a vital need throughout urban and suburban Pennsylvania. They not only encourage walking, but they also improve the safety of pedestrians. One study found that streets without sidewalks had 2.6 times more pedestrian/automobile collisions than expected on the basis of exposure, while streets with sidewalks on only one side had 1.2 times more pedestrian crashes than those with sidewalks on both sides of the street.*

4.1 Overall Design

An individual's decision to walk is as much a factor of convenience as it is the *perceived quality* of the experience. Pedestrian facilities should be designed with the following factors in mind:

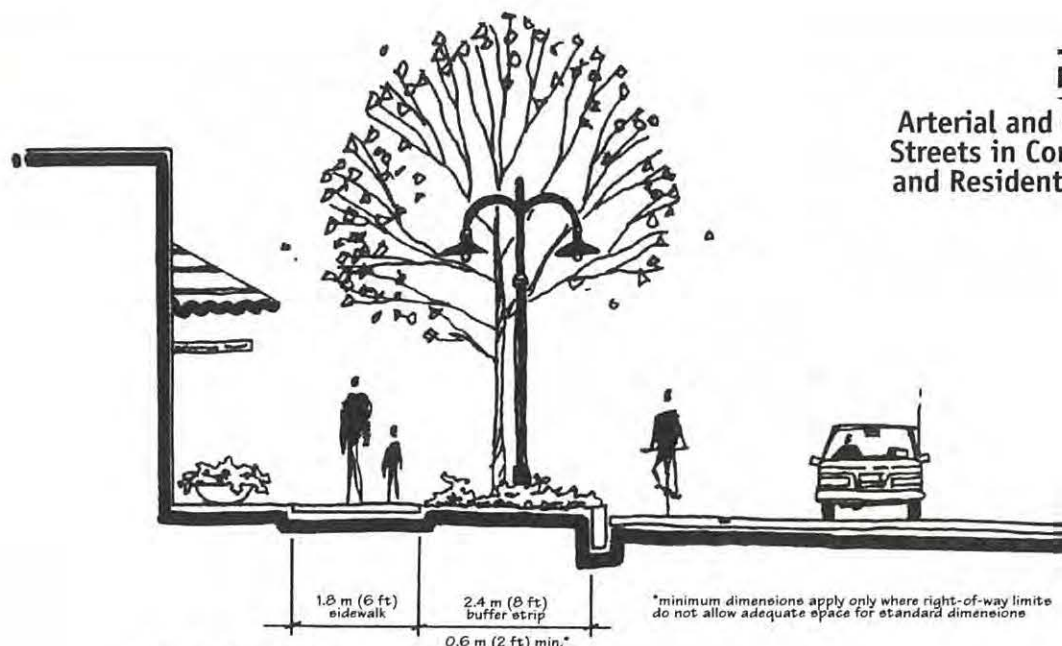
- Sufficient Width — Sidewalks should accommodate anticipated volumes based on adjacent land uses, and should at a minimum allow for two adults to walk abreast.
- Protection from Traffic — High volume and/or high speed, >55 km/h(>35 mph), motor vehicle traffic creates dangerous and uncomfortable conditions for pedestrians. Physical (and perceptual) separation can be achieved through a combination of methods: a grassy planting strip with street trees, a raised planter, bicycle lanes, on-street parallel parking, and others.
- Street Trees — Street trees are a desirable element in a high quality pedestrian environment. Not only do they provide shade, they also give a sense of enclosure to the sidewalk environment - which enhances the pedestrian's sense of walking in a protected environment.
- Pedestrian-Scale Design — Large highway-scale signage reinforces the general notion that pedestrians are out of place. Signage should be designed to be seen by the pedestrian. Street lighting should likewise be scaled to the level of the pedestrian, instead of providing light poles that are more appropriate on high-speed freeways.
- Continuity — Pedestrian facilities are often discontinuous, particularly when private developers are not encouraged to link on-site pedestrian facilities to adjacent developments and nearby sidewalks or street corners. New development should be designed to encourage pedestrian access from nearby streets. Existing gaps in the system should be placed on a prioritized list for new sidewalk construction.
- Clearances — Vertical clearance above sidewalks for landscaping, trees, signs and similar obstructions should be at least 2.4 meters (8 feet). In commercial areas and the Central Business District, the vertical clearance for awnings should be 2.7 meters (9 feet). The vertical clearance for building overhangs which cover the majority of the sidewalk should be 3.6 meters (12 feet).

Sidewalk design should be consistent with ADA requirements. It is important to note that new ADA rules under present consideration by the federal government would require sidewalks on both sides of most roadways. If these standards are adopted, they will supersede the guidelines provided herein. Figure 9 describes nationally accepted guidelines for installing sidewalks. These may be adapted for use in Pennsylvania by individual communities.

***Note:** Reference from *Investigation of Exposure Based Pedestrian Areas*, Knoblauch, 1988.

Figure 10:

Arterial and Collector Streets in Commercial and Residential Areas



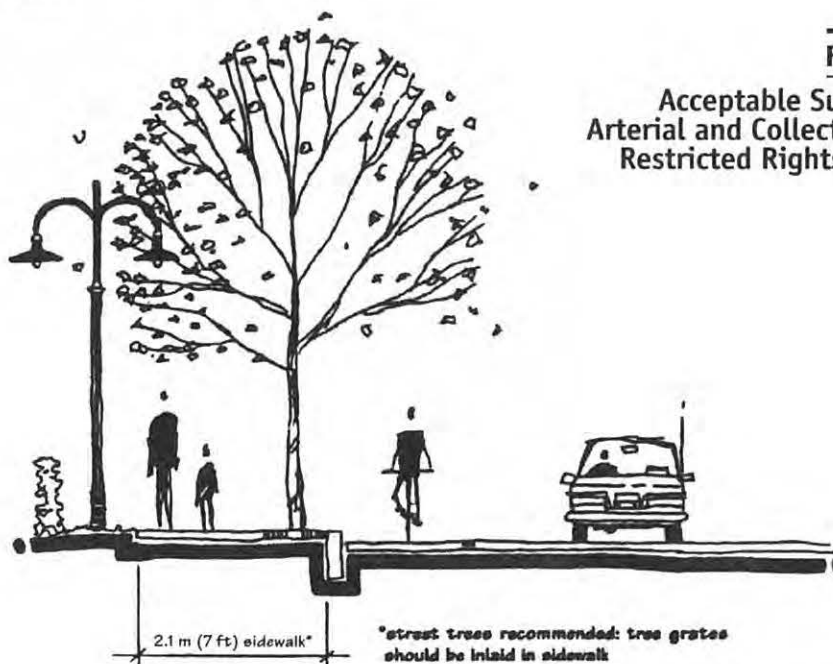
Typical Cross Section:
Arterial and Collector Streets
in Commercial and Residential Areas

Speed Limits 55 km/h (35 mph) or less

Source: Greenways Incorporated

Figure 11:

Acceptable Substitute
Arterial and Collectors with
Restricted Rights-of-Way



Typical Cross Section:
Acceptable Substitute
Arterial and Collectors with Restricted Rights-of-Way
Speed Limits 55 km/h (35 mph) or less

Source: Greenways Incorporated

4.3 *Continuity in Construction Zones*

Work zone areas can completely disrupt pedestrian circulation patterns, and often create total barriers for pedestrians. Just as traffic is re-routed during roadway construction, pedestrians should be provided with a safe alternative through the work zone. If a safe alternative is *not* provided, pedestrians will often try to make their way across the site unprotected.

Pedestrians should be re-routed well in advance of the construction barriers, since most are unlikely to retrace their steps to get around the work zone. The MUTCD provides appropriate signage for these situations, and provides limited guidance for pedestrian detours. If a pedestrian circulation path is to be provided within the work zone, it should be constructed of a smooth and even surface, with no gaps. Pedestrians should be protected from construction vehicle traffic, roadway traffic and falling debris.

Construction sites are particularly difficult to traverse for disabled pedestrians. An alternate accessible route should always be provided when the main accessible route is interrupted by construction activities.

4.4 *Sidewalk Surface Construction*

Sidewalks and roadside pathways should be constructed of a solid, debris-free surface. Regardless of the type of surface chosen, it must be designed to withstand adequate load requirements. Standard depth of pavement should consider site specific soil conditions, and is therefore left to local discretion. Brick and concrete pavers are popular materials for more decorative sidewalks. The use of stylized surfaces is encouraged, however they must be installed properly or they will deteriorate over time.

4.5 *Width and Setback Standards for Sidewalks*

The following are recommended guidelines for sidewalk width and setback in Pennsylvania. It is important to note that there are some areas that warrant wider sidewalks than the minimum. For example, sidewalks in and around a university must accommodate a much higher volume of pedestrians, and therefore warrant additional width.

- Central Business District

Sidewalk widths in the CBD should meet the desired level of service standards set by the Highway Capacity Manual.

- Commercial and Residential Areas Outside of CBD: Arterial and Collector Streets

The minimum recommended width for sidewalks on arterial and collector streets in commercial and residential areas is 1.8 meters (6 feet). For new roadway construction, the sidewalk should be set back from the curb and gutter by a minimum of 2.4 meters (8 feet). For roadway widening projects with right-of-way limitations (and retrofit projects with inadequate shoulder space for sidewalks), a minimum of a 0.6 meter (2 foot) wide planting strip should be installed. If no planting strip is possible, the minimum width of the sidewalk should be 2.1 meters (7 feet). See Figures 10 and 11.

5.0 Intersection Design for Pedestrian Safety

Intersection design is extremely important for the safety of pedestrians. No single feature creates a safe intersection for pedestrians - the design elements described below should be combined as site conditions warrant.

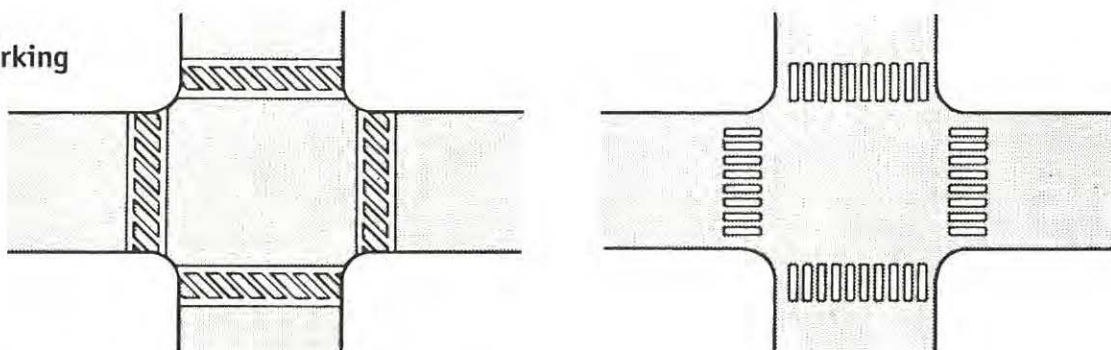
In addition to the guidelines below, reference PennDOT's May 31, 1994 Strike-off Letter (subject: No Pedestrian Crossing Signs and Overhead Street Name Signs) for additional information regarding the accommodation of pedestrians in all phases of intersection operations.

5.1 Crosswalks

Marked crosswalks should be provided at intersections that carry significant pedestrian volumes, or where newly installed sidewalks are likely to generate more pedestrian traffic. Criteria for installing crosswalks is shown in Figure 14.

Crosswalks can serve to channel pedestrian traffic through an intersection, as well as heighten the awareness of motorists of possible pedestrian crossing movements. It is important to note that although crosswalks are an important element in intersection design, a crosswalk alone does not ensure the safety of a pedestrian. Too often, crosswalks are the sole provision for pedestrians at intersections when other safety measures are also needed.

Figure 13
Crosswalk Marking Patterns



Source: Manual on Uniform Traffic Control Devices

Chapter 3B-18 of the MUTCD provides guidance on crosswalk design. High visibility designs are recommended for use in Pennsylvania (the designs in Figure 13 offer the highest visibility). Crosswalk lines should be 305 millimeters to 610 millimeters (12 inches to 24 inches) in width and spaced 305 millimeters to 610 millimeters (12 inches to 24 inches) apart. A non-skid, long-life striping material is the preferable marking material for bicycle and pedestrian facilities.

The optimum width of crosswalks is 3 meters (10 feet wide), with a minimum width (as set by the MUTCD) of 1.8 meters (6 feet wide). Wider crosswalks should be installed at locations with higher pedestrian volumes. At intersections with stop bars, a minimum separation of 1.2 meters (4 feet) is necessary between the stop bar and edge of the crosswalk.

- Residential Area outside of CBD: Local Streets

On local streets in residential areas, sidewalk width should be based on the number of units per acre. For multi-family developments and single-family homes with densities that exceed 4 units per hectare (acre), the sidewalk should be a minimum of 1.8 meters (6 feet) wide with a minimum setback of 1.4 meters (4.5 feet) for new construction or 0.6 meters (2 feet) retrofit. For densities up to four dwelling units per hectare (acre), the sidewalk should be a minimum of 1.5 meters (5 feet) wide with a minimum setback of 1.4 meters (4.5 feet) for new construction or 0.6 meters (2 feet) retrofit. See Figure 12.

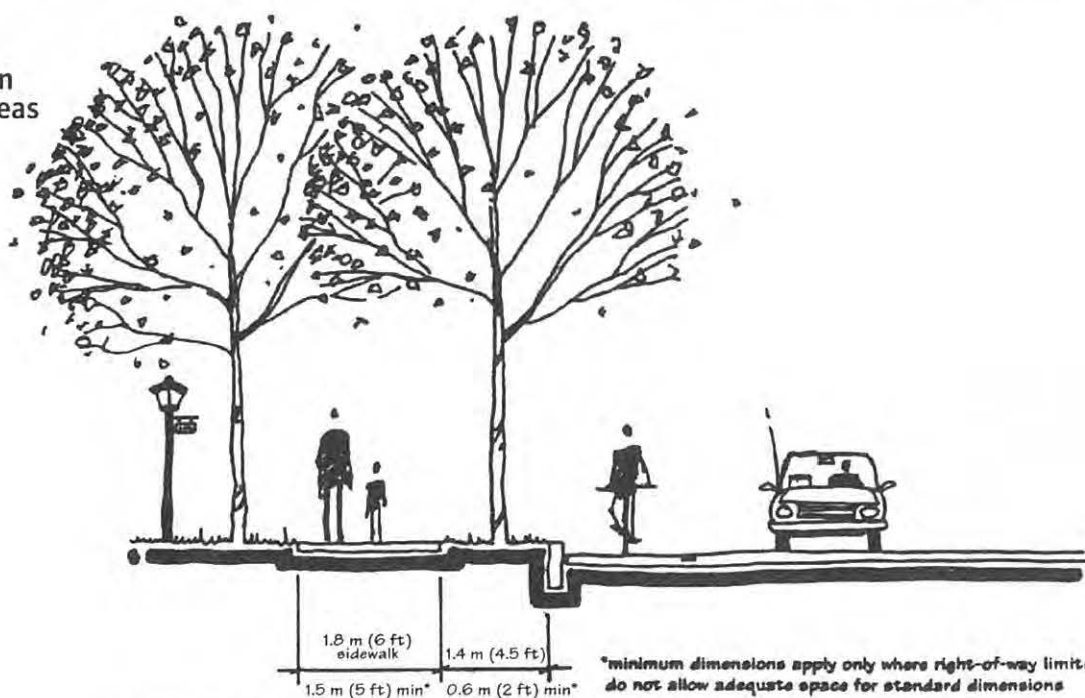
An important note regarding streets with no curb and gutter:

The setback requirements in this section are based on roadway cross sections that include a curb and gutter. Sidewalks located adjacent to “ribbon pavement” (pavement with no curb and gutter) have a greater setback requirement, depending on roadway conditions. Engineers should consult the AASHTO Policy on Geometric Design of Highways and Streets for more specific guidelines.

- Rural Roadways

In most rural areas, the low volume of pedestrians does not warrant sidewalk construction. In most cases, 1.2 meter (4 foot) wide paved shoulders can provide an adequate area for pedestrians to walk on rural roadways, while also serving the needs of bicyclists. Exceptions should be made in areas where isolated developments such as schools, ballparks, or housing communities create more pedestrian use. For example, motorists might regularly park along a rural road to access a nearby ballpark. A sidewalk may be warranted in this circumstance so that pedestrians can walk separately from traffic. Sidewalks in rural areas should be provided at a width based on anticipated or real volume of pedestrians, with 1.5 meters (5 feet) being the minimum width.

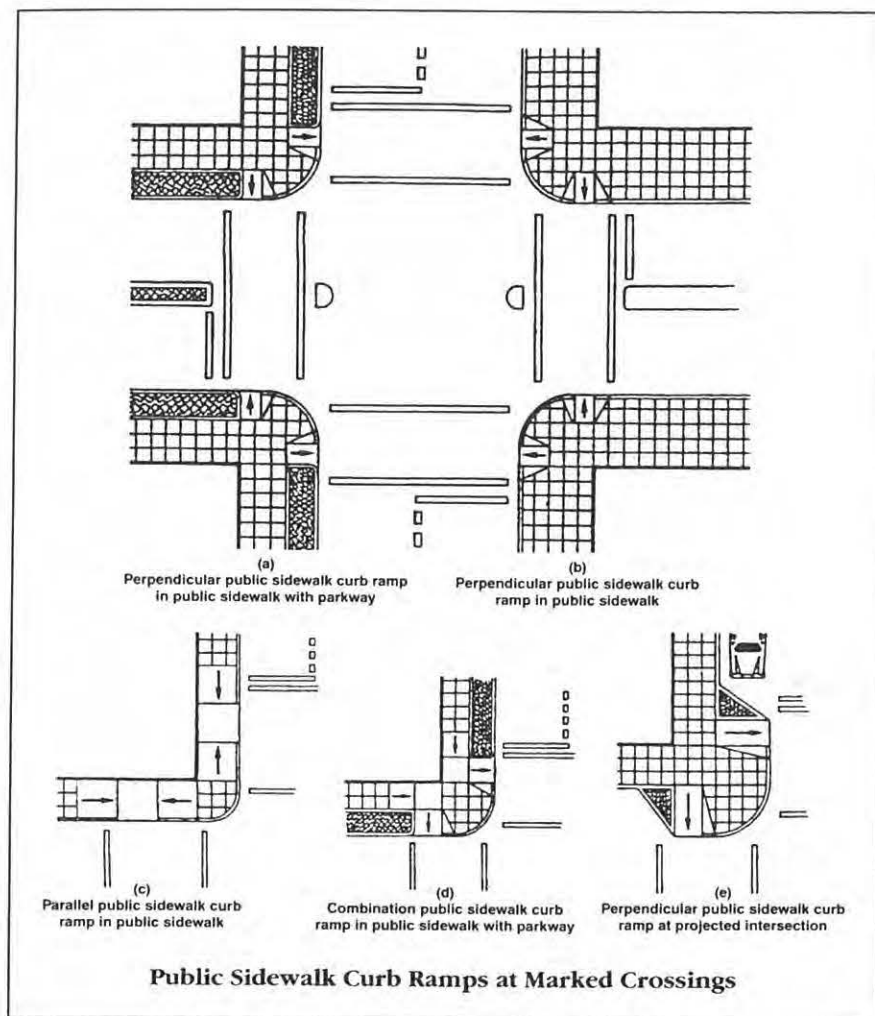
Figure 12:
Local Streets in Residential Areas



Typical Cross Section:
Local Streets in Residential Areas
Speed Limits 55 km/h (35 mph) or less

Source: Greenways Incorporated

Figure 15:
Curb Ramps at
Marked Crossings



Source: ADA

5.3 Traffic Signals

Pedestrian safety at intersections depends in part on minimizing the length of time that the pedestrian is exposed in the street. One way of minimizing conflict at intersections is to improve the phasing of traffic signals. Traffic signal improvements for pedestrians may include the following provisions:

- Improvements to timing options and turn phasing
- Elimination of right-turn-on-red movements
- Elimination of free-right turning movements (with yield signs)
- Addition of pedestrian signals (walk/don't walk)
- Push-button signals that can be tripped by pedestrians
- Reduced corner radii to shorten the distance the pedestrian must cross, therefore also shortening the signal interval

5.2 Curb Ramps

A deciding factor in the location and design of crosswalks is the placement of curb ramps at street corners. Curb ramps should always be placed to lead the pedestrian directly into the striped crosswalk area. Corners should either include two curb ramps, or one broad ramp that serves both crosswalks. Curb ramps should always be provided with a matching ramp on the opposite side of the road, as well as ramps at pedestrian refuge islands.

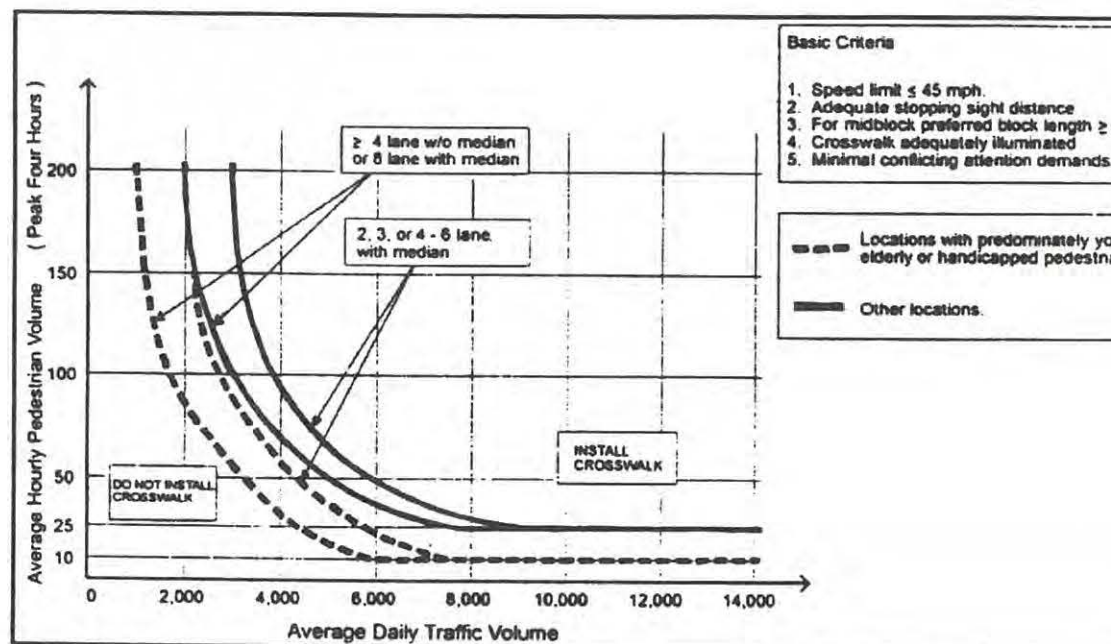
ADA guidelines illustrate several acceptable designs for curb ramps at marked crosswalks. See Figure 15.

Current ADA standards state that the slope of curb ramps cannot exceed 1:12, with a maximum rise of 762 millimeters (30 inches). If the curb ramp is located in an area where pedestrians might typically walk, it must have flared sides that do not exceed a slope of 1:10. It is also extremely important that the bottom of the curb ramp be even with the street surface. A raised lip at the street edge can cause a wheelchair to tip over, even if it is only 6 millimeters (one-eighth inch) high.

One somewhat controversial provision in ADA applies to the use of raised truncated domes as a textural surface on curb ramps. The intent of these domes is to provide a tactile warning to visually-impaired pedestrians who might not otherwise be aware of an upcoming intersection. Some municipalities across the country are experimenting with other types of detectable warnings on ramps, because the raised domes have been criticized as being a safety hazard.

Reference Section 6.3 of PENNDOT's Design Manual: Part 2 Highway Design (1999 edition) for additional information on the design of curb cut ramps.

Figure 14:
Criteria for Installing Crosswalks



Source: Adapted from *Planning, Design and Maintenance of Pedestrian Facilities*, 1989.

Note: See Metric Conversion Tables in Appendix.

allow a resting area for slower pedestrians who cannot make it across the intersection within the time allotted. In wider urban intersections, refuge areas allow pedestrians to cross one direction of traffic at a time, and provide a place to wait for the next pedestrian cycle. In this case, they also reduce the overall delay to motor vehicles who would otherwise have to stop for an interval that would allow a pedestrian to cross the entire length of the intersection.

Medians and refuge areas can be particularly important for urban intersections with center turn lanes and left turn signals. Traffic signals that serve these intersections often do not allow adequate time for the pedestrian to traverse the length of the intersection. The center median therefore provides a refuge for pedestrians who must wait through several cycles for a clear zone.

A pedestrian refuge should be provided at intersections with crossing distances that cannot be made within the time allotted by the signal phasing (assuming a standard rate of travel at 1.1 meters (3.5 feet) per second). Refuge areas should also be installed at intersections with crossing distances that exceed 23 meters (75 feet), or with a high volume of elderly or disabled pedestrians.

The minimum width for medians should be 1.2 meters (4 feet), with 1.8 meters (6 feet) being a preferred width. The length of the island should be based in part on the geometric design of the approaching traffic lanes, but should not be less than 6 meters (20 feet). The design of the island should meet ADA standards, with curb cuts provided.

6.0 Special Types of Crossings

6.1 *Midblock Crossings*

In situations where a midblock crossing formalizes a pedestrian activity that is already occurring, provision of a crossing can improve the visibility of the pedestrian and help to reduce auto/pedestrian collisions. Midblock crossings can also serve to channel several unofficial pedestrian crossings to one area. Traffic and engineering studies should be performed before formalizing any such crossings.

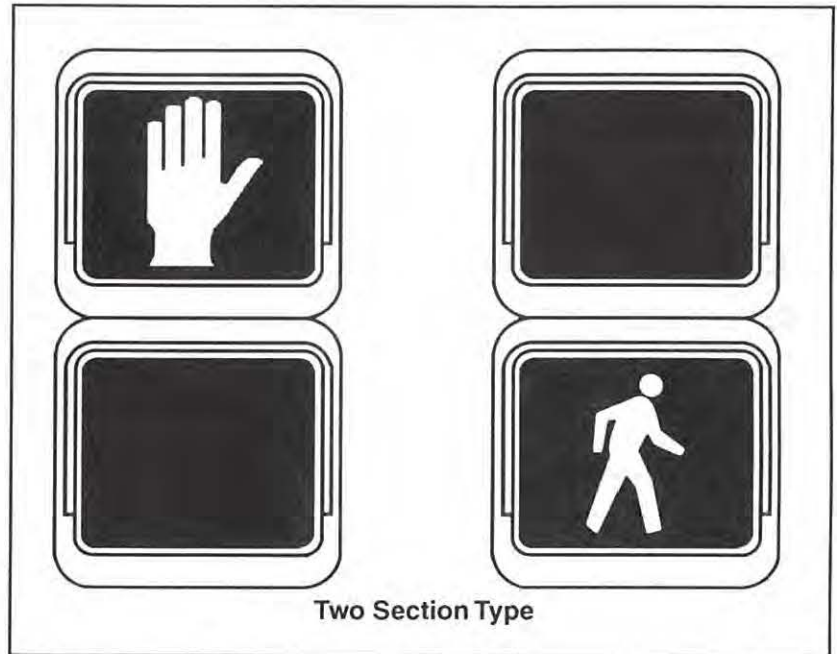
Midblock crossings are most appropriate in locations where a high pedestrian traffic generator is located directly across the street from a significant source of pedestrians. Examples would include a commercial area with fast food restaurants across the street from a university, or a shopping center across from a high school.

However, due to the increased safety risk of a pedestrian crossing in midstream traffic, midblock crossings should be generally discouraged unless one or more of the following conditions apply:

- The location is already a source of a substantial number of midblock crossings, or is anticipated to generate midblock crossings (for new development), and a traffic engineering evaluation indicates the crossing can be safely accommodated.
- The land use is such that a pedestrian is highly unlikely to cross the street at an adjacent intersection, and when midblock crossings would be frequent.
- The safety and capacity of adjacent intersections creates a situation where it is dangerous to cross the street, except at a designated midblock location.

Extensive guidelines for traffic signalization to accommodate pedestrian crossings are provided in the MUTCD. Traffic engineering analysis is necessary on a case-by-case basis in order to determine the best signal option. Signalized intersection design and audible signals should be given special consideration in areas with higher numbers of senior citizens, school-age children and disabled persons. See Figure 16.

Figure 16:
Pedestrian Signal Heads



Source: Manual on Uniform Traffic Control Devices

5.4 On-Street Parking

The presence of parked cars near intersections has been cited as a contributing factor in many pedestrian accidents in urban areas. Parked cars block visual access to oncoming traffic, so that both pedestrians and motor vehicles cannot see each other. Consideration should be given to removing parking in the immediate vicinity of crosswalks.

5.5 Turning Radii

One aspect of intersection design that is often overlooked is the turning radii of corners. A wide turning radius can increase crossing distance, as well as increase the speed of turning traffic. However, a turning radius that is too small can cause long vehicles (such as flatbed trucks and buses) to jump the curb edge and eventually cause the curb to crumble or possibly hit pedestrians waiting to cross. The optimum design is a compromise between the two. AASHTO allows a corner radius in which the turning vehicle uses the entire width of the receiving roadway.

5.6 Medians and Refuge Areas

In general, pedestrians are better accommodated when roadway width at intersections is narrower, thereby making medians unnecessary. However, pedestrian refuge areas can be essential for large, multi-lane urban intersections. These islands serve several purposes. They

- Where one or more of the conditions stated above exists in conjunction with a well-defined pedestrian origin and destination (e.g., a residential neighborhood across a busy street from a school, a parking structure affiliated with a university, or apartment complex near a shopping mall).

***Note:** Reference from Pedestrians and Traffic Control Measures, Zegeer, 1988.

It is important to provide adequate lighting of the crossing to prevent crime and vandalism. Underpasses often need lighting 24 hours a day. Topography should be a major consideration in determining whether an underpass or overpass is more appropriate. These facilities are regulated by ADA standards, therefore extensive ramping is usually necessary to meet the grade requirements.

6.3 *Expressway Ramps*

Pedestrian safety is often jeopardized in areas where expressway ramps intersect with arterial, collector and local streets. A pedestrian circulation plan should be developed for interchange exit and entrance ramp locations, particularly for areas with the following characteristics:

- Areas with substantial pedestrian volume or nearby pedestrian attractors
- Where existing sidewalks are located in the vicinity of expressway exits/entrances
- Where new sidewalks are planned for the vicinity of expressway exits/entrances

Several measures can increase the awareness of motorists and improve conditions for pedestrians at interchanges. Ramp width should be minimized to reduce the crossing distance for pedestrians. Warning signs should be posted on exit ramps to warn motorists of upcoming pedestrian crossings. Motorists should be encouraged to quickly reduce their vehicle speed after exiting the highway, both through signage and traffic calming methods.

It should be noted that it is difficult to correct all of the problems associated with expressway entrance and exit ramps on local streets. In some cases, these areas will always be unfriendly for pedestrians due to the limiting factors of high speed exiting traffic and poor sight distance. Extra care should be taken to improve these areas for pedestrians wherever possible.

6.4 *Bridge Crossings*

Bridges often present a “bottleneck” for pedestrians. Bridges often have less shoulder area, therefore squeezing pedestrians closer to fast traffic. At the same time, the confines of the bridge structure often provide no refuge area from errant vehicles.

New bridges should be constructed with adequate space for pedestrians and bicycles. Minimum accommodations should include a 1.5 meter (5 foot) wide sidewalk and a 1.2 meter (4 foot) bicycle lane or paved shoulder. These guidelines apply both to new bridge projects and to bridge improvement projects, except for those on limited access freeways.

It is also important to provide paved shoulders and sidewalks to the above dimensions where roadways pass under bridges, so that these areas do not present a barrier to pedestrians.

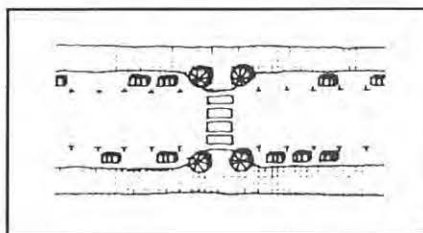
In special situations, it may be necessary to construct a physical barrier between pedestrian traffic and motor vehicle traffic on bridges. An engineering analysis of cost effective-

- Spacing between adjacent signals exceeds 180 meters (600 feet).
- The capacity of the facility will not be seriously impeded by the midblock crossing.
- Other lesser measures to encourage pedestrians to cross at adjacent intersections have been unsuccessful.

On-street parking can reduce sight distances at midblock crossings. In areas with on-street parking, midblock crossings should include highly visible crosswalk markings and a flared-out curb extension as shown in Figure 17.

Another measure to improve motorist awareness of the midblock crossing is to erect overhead pedestrian crossing signs on span wires or mast arms above the street. In cases of extremely high pedestrian volume during certain times of the day, a signalized intersection with pedestrian push-buttons should be considered.

Figure 17:
Mid-Block Flare



Source: *Planning and Implementing Pedestrian Facilities in Suburban and Developing Rural Areas*, TRB Report 294A.

6.2 Grade-separated Crossings

For essential pedestrian crossings that cannot be accomplished in a safe manner, either due to a high volume of pedestrians or a high volume of motor vehicle traffic, grade-separated crossings should be provided. For design criteria for pedestrian grade-separated crossings, refer to Section 6.2 of *PennDOT's Design Manual: Part 2 Highway Design* (September 1992 edition), and *AASHTO Bridge Specifications*.

Convenience is essential in designing over- and under-passes. Studies have shown that pedestrians can rarely be convinced to use a poorly located crossing — and will almost never use an overpass if it takes 50 percent longer to cross than an at-grade crossing. Grade-separated crossings should be provided within the normal path of pedestrians wherever possible. Even for the most ideal overpass location, it may still be necessary to block pedestrian access to the at-grade crossing with fencing.

A 1988 study* concluded that state and local governments usually consider grade-separated crossings in the following situations:

- Where there is moderate to high pedestrian demand to cross a freeway or expressway.
- Where there is a large number of young children (i.e., particularly near schools) who must regularly cross a high-speed or high-volume roadway.
- On streets having high vehicle volumes and high pedestrian crossing volumes and where there is an extreme hazard for pedestrians (e.g., on wide streets with high-speed traffic and poor sight distance).

the entrances to buildings (where automobile and pedestrian traffic conflict), along any stretch of roadway where slower speeds are desired, and at sites where a major pedestrian attractor lies across a street from a source of pedestrians.

Design Considerations

- Speed tables should be a minimum of 3.6 meters (12 feet) long and 76 millimeters (3 inches) in height.
- Speed tables are appropriate in areas where the speed limit is 55 km/h (35 mph) or less.
- Speed tables should always be clearly marked with a bright non-skid surface.
- Gradients on the approach and exit slopes should not exceed 16%.
- Ramp edges should be flush with the road surface.
- Speed tables can be designed to extend from curb to curb, or a 0.9 meter (three foot) cut can be made at both sides to allow a flat area for bicycles to pass through, and to facilitate drainage. However, the approach ramps for speed tables are usually gentle enough that they do not cause problems for cyclists, if properly marked.

Municipal traffic engineers should be responsible for the appropriate location and design of speed tables. Further guidance is provided by the ITE Guidelines for the Design and Application of Speed Humps - A Proposed Recommended Practice.

7.3 Curb Extensions

Curb extensions or “bulb-outs” are extensions of the sidewalk and curb into the street on both sides of a pedestrian crosswalk. Curb extensions have several advantages for the pedestrian. The primary benefit is a shorter crossing distance at an intersection. Shortening this distance decreases the amount of time the pedestrian is exposed to traffic. By narrowing the traffic lane and creating a smaller corner radius, curb extensions also reduce traffic speeds at the intersection. Curb extensions increase visibility for the pedestrian in areas with on-street parking by offering an unimpeded view of oncoming traffic (and allowing on-coming traffic to also see approaching pedestrians). Lastly, curb extensions can provide additional space for landscaping to improve the visual quality of the street. See Figure 18.

Curb extensions can be used in conjunction with speed tables. Care should be taken in the design of curb extensions so as to allow both the auto and the cyclist to pass through with sufficient room. Curb extensions can also be used at mid-block crossings.

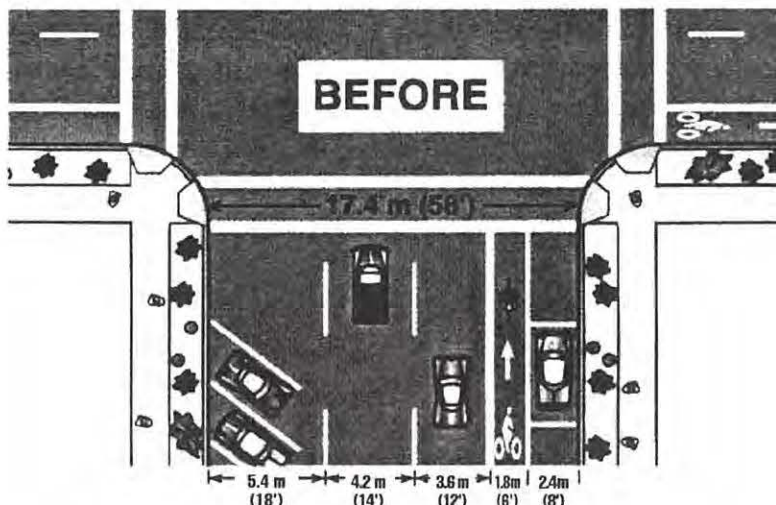


Figure 18:
Curb Extensions

tiveness and need should be conducted prior to choosing this option, due to the extreme cost of construction and long-term maintenance.

In areas where a barrier is warranted, the safety benefits to pedestrians can be substantial. It is important to note, however, that curbs do not qualify as adequate barriers. Except when traveling at very low speeds, motor vehicles can easily mount curbs and harm pedestrians.

7.0 Pedestrian-Cautious Roadways

High speed traffic creates dangerous conditions for pedestrians, and reinforces the notion that walking is unsafe and uncomfortable. One important feature of a balanced transportation system is slower motor vehicle speeds in areas that attract pedestrians and cyclists, particularly on residential streets. Slower speeds also enable motorists to widen their field of vision, becoming much more aware of other users. A variety of methods to reduce speeds are listed below. (It is usually necessary to integrate several methods to reduce speeds, rather than rely on only one.)

7.1 Street Layout

Engineers typically design a roadway to accommodate a certain level of speed. The layout and design of a street can also be intentionally engineered for slower speeds. Such roadway design methods include:

- **Interrupted Sight Lines.** If motorists can see a long way into the distance, their speed increases. The interruption of sight lines with changes in the road's direction, roundabouts, "neck-downs" or breaking the road into smaller visual units with paved strips across the road causes the driver to slow down.
- **Narrowed Traffic Lanes.** Wide lanes encourage greater speed.
- **Protected Parking.** The roadway can appear to have been narrowed simply by building landscaped islands out from the footpath to provide protected parking bays.
- **Neck-downs.** Landscaped islands intrude into the roadway to form a narrow "gate" through which the driver must pass.
- **Changes in the Street Surface.** Paved or cobblestone strips across the road cause a slight vibration in the car which causes the driver to slow down. Consideration should be given to the cyclist's need for a smooth pavement surface at the edge of the street. Specialty pavement should be properly installed for low maintenance.

7.2 Speed Tables

Speed tables are elongated versions of speed bumps. They can serve a dual purpose, both as a method of slowing traffic, and as a highly visible pedestrian crosswalk. Research has also shown that average vehicle speeds are reduced to 25 km/h (20 mph) where speed tables are spaced up to 100 meters (328 feet) apart. Speed tables can be crossed at high speeds, although very few motorists do so.

Speed tables are appropriate for use on residential streets, at midblock crossings on residential and arterial streets, at intersections with heavy pedestrian traffic, between parking areas and

3. As the offset distance decreases from 1.5 meters (5 feet), the opening width would increase.
4. The outside 0.6 meters (2 feet) of the roundabout will be constructed with mountable monolithic concrete curb doveled to the existing pavement. The street will be broken and removed from the center of the curb for planting.
5. Modern roundabouts will be landscaped with one to three trees set back 1.2 meters (4 feet) from the curb.

8.0 Pedestrian Facility Maintenance

Facility maintenance is an important aspect of creating adequate and comfortable facilities for pedestrians. A crumbling sidewalk is not only an eyesore but a hazard to pedestrians — and often a barrier to the disabled. Regular maintenance protects the public investment in pedestrian facilities and keeps them in working order.

A periodic inspection schedule for pedestrian facilities should be adopted by local jurisdictions. Crosswalks will need re-striping on a regular schedule, based on the material used in the striping. A general maintenance budget should be allocated by each local government for use on a yearly basis, perhaps combined with a maintenance budget for bicycle facilities.

The charts shown in Figure 20 on the following pages provide descriptions of typical maintenance needs for pedestrian facilities, as well as recommended repair practices.

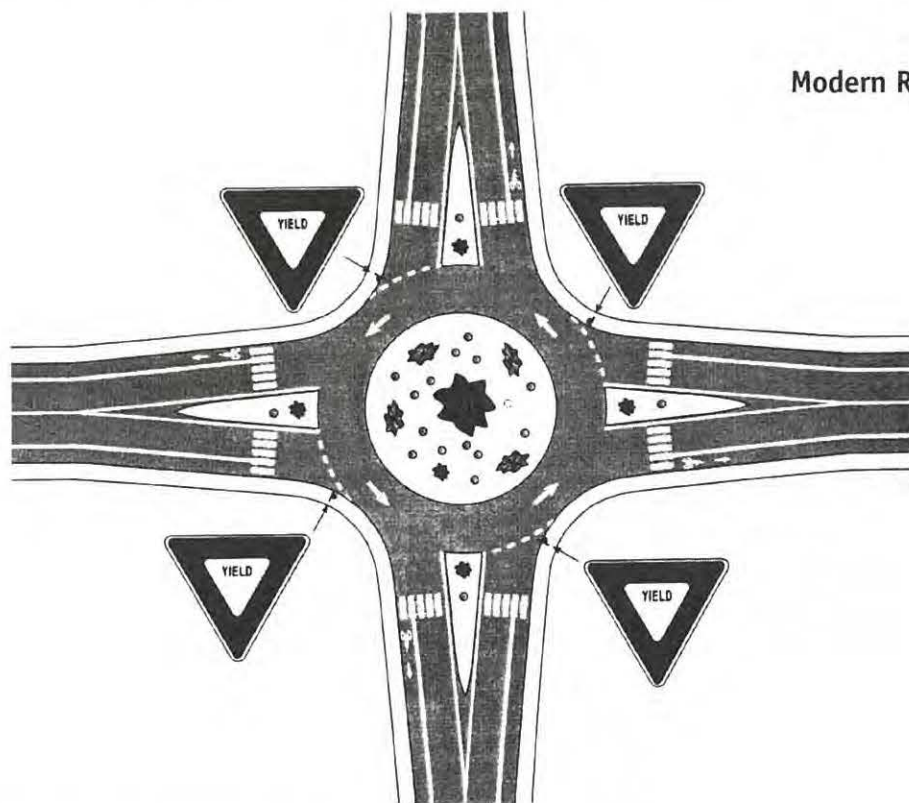
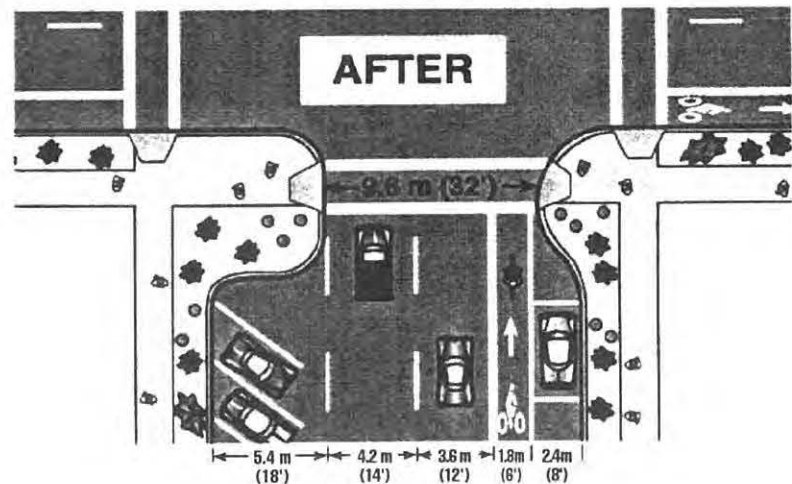


Figure 19:
Modern Roundabout

Source: Oregon Bicycle and Pedestrian Plan, June 1995.

Figure 18:
Continued



Source: *Oregon Bicycle and Pedestrian Plan*, June 1995.

7.4 Modern Roundabouts

Roundabouts, or small traffic circles, can be effective in reducing motor vehicle speeds. They are useful mostly as a psychological deterrent to through-traffic on neighborhood streets, and are usually effective only if included in a system of traffic controls. Roundabouts are becoming more popular in the United States. The City of Seattle, Washington recently installed more than 200 roundabouts at four-way stops and uncontrolled intersections. Figure 19 is an example of a roundabout design adopted in Oregon.

The following guidelines should be used when planning and designing modern roundabouts:

- If the objective is to reduce traffic speeds along a section of a residential street, two or more roundabouts at adjacent intersections should be used. A single roundabout will slow traffic in the immediate vicinity of the intersection, but its impacts on traffic speeds will generally be confined to within approximately 30 meters (100 feet) of the roundabout.
- A roundabout should not be installed in an intersection with a high volume of left-turn movements. Many motorists will make left turns on the left of the circle. This creates conflicts with traffic approaching from the left.
- Warning and directional signage should be used at roundabouts.
- Other speed reduction techniques such as speed tables can help to further reduce speeds in the vicinity of roundabouts.
- Roundabouts should be physically raised from the road. Motorists tend to ignore painted circles or changes in pavement texture that indicate a roundabout.

In Seattle, Washington, design guidelines have been developed for roundabouts that allow for through movement of large trucks. These design criteria also ensure an island of sufficient size to be landscaped with large shrubs or trees, which increase the visibility of the upcoming island.

1. The distance between the roundabout and street curb projection (the offset distance) shall be a maximum of 1.5 meters (5 feet).
2. The width between a roundabout and a curb return shall be between 4.8 and 6.0 meters (16 and 20 feet).

Figure 20:
Continued

Pedestrian Facility	Concern	Maintenance Activity
Crosswalks and Curb Ramps	1. Curb ramp surface is worn into a glazed and slippery surface.	1. Replace curb ramp. Texturize surface with shallow, transverse grooves.
	2. Poor drainage causing water retention in gutter area.	2. Clean gutter and catch basin area.
	3. Street rutting causing water ponding in crosswalk.	3. Resurface street or crosswalk area.
	4. Street repaving resulting in step or transition problem at bottom of curb ramp.	4. Repaving contract specifications should specify a maximum of 6 mm (1/4 in) vertical edge between new pavement and gutter or curb ramp.
	5. Slippery manhole covers in crosswalk.	5. When manholes must be located in crosswalk, they should have slip resistant cover design and be flush with the surface and visible.
	6. Snow and ice buildup and ponding from snow melt.	6. A maintenance program should be developed to ensure snow and ice removal.
	7. Stop bar and crosswalk pavement markings.	7. Identify high volume locations that require additional refurbishing activities.
	8. Separation of expansion and construction joints so that space between adjoining sections are greater than 13 mm (1/2 in).	8. Fill joint with hardening expansion compound.
	9. Pedestrians do not have time to clear roadway prior to signal change.	9. Review pedestrian clearance/timing plan assuming a maximum speed of 1.1m (3.5 ft) per second plus a tolerance of 2 seconds for reaction time. Add refuge island in middle of street. Extend sidewalk to edge of parking lane.
Shoulders	1. Debris, trash and loose sand on shoulder.	1. A maintenance program should be developed to provide for regular sweeping of shoulders.
	2. Snow and ice buildup.	2. A maintenance program should be developed to ensure snow and ice removal.
Overpasses and Underpasses	1. Falling objects from overpass.	1. Enclose overpass with chain-link fencing.
	2. Sparse pedestrian use of underpasses.	2. Underpass should be well lighted to provide a feeling of personal security.
	3. Worn step or ramp surfaces.	3. Overlay, replace or texturize to slip free and unbroken surface.
	4. Snow and ice buildup and ponding from snowmelt.	4. A maintenance program should be developed to ensure snow and ice removal.
	5. Section pop-up of vertical height greater than 13 mm (1/2 in).	5. Replace defective section or provide temporary asphalt shim.

Figure 20:

**Pedestrian Facility
Maintenance Activities**

Pedestrian Facility	Concern	Maintenance Activity
Sidewalks and Walkways	1. Tree roots cracking and heaving the sidewalk.	1. Remove failed sidewalks, cut roots and install new sidewalk. A local arborist should be contacted prior to removing large roots.
	2. Section pop-up of vertical height greater than 13 mm (1/2 in).	2. Replace defective section or provide temporary asphalt shim.
	3. Cracked or spalling surface and poorly placed temporary patches.	3. Replace defective sections.
	4. Snow and ice buildup and ponding from snow melt.	4. Enact and enforce local regulations requiring abutting land users to perform timely clearance activity. Hire private contractor to clear sidewalk and assess cost to abutting land users.
	5. Separation of expansion and construction joints so that space between adjoining sections are greater than 13 mm (1/2 in).	5. Fill joint with hardening expansion compound.
	6. Trash, loose sand, oil and grease on walkways.	6. Serve notice to abutting land owners to clean and maintain sidewalks.
	7. Materials, signs, vending machines, etc. restricting effective sidewalk width.	7. Require responsible parties to remove obstructions.
	8. Low hanging tree limbs, bushes, weeds and other foliage growing into sidewalk and/or posing obstructions and sight restrictions.	8. Enact and enforce local regulations requiring abutting land users to perform timely clearance activity. Hire private contractor to clear sidewalk and assess cost to abutting land users.

Appendix

Figure 20:
Continued

Pedestrian Facility	Concern	Maintenance Activity
Work Zones	1. Temporary pathways at work zones are typically constructed of relatively inexpensive, short life materials.	1. The pathway surface should be frequently inspected. Pathway surface materials constructed of wood should be treated with no slip strips or surface treatment. Surface materials with holes, cracks or abrupt changes in elevation should be replaced.
	2. Detour pedestrian paths place greater volumes on detour roadway.	2. The detour pathway should be checked periodically for: <ul style="list-style-type: none"> • Adequacy of pedestrian and vehicular signal timing. • Proper pedestrian detour signing. • Pedestrian traffic hazards. • Proper motorist information.
	3. Construction materials debris in pathway.	3. Require the contractor to maintain a clear pathway.
	4. Changing pedestrian accommodation needs due to dynamic construction activities.	4. Perform periodic inspection to ensure pedestrian information needs keep pace with construction activities.
	5. Damaged traffic barriers.	5. Damaged traffic barriers should be replaced and their adequacy reevaluated to ensure pedestrian safety.
Traffic Control Devices	1. Signs must be readily visible to pedestrians.	1. Inspect the signs from the vantage point of the pedestrian who is expected to read it. The signs should not be obscured by other signs or foliage.
	2. Pedestrian signs must be at a mounting height that can be read by all pedestrians.	2. If the sign extends into an accessible route they must be mounted in accord with the MUTCD to permit safe passage under the sign. Signs mounted on a wall should be mounted at a height between 1370 millimeters and 1675 mm (54 in and 66 in).
	3. Pedestrian signals must be maintained.	3. Pedestrian signals should be periodically: <ul style="list-style-type: none"> • Inspected for damage due to turning vehicles. If damaged, consider back bracketing the pedestrian assembly. • Refurbish, including lens cleaning and bulb replacement.

Source: *Planning, Design and Maintenance of Pedestrian Facilities*, FHWA, 1989.

Appendix A — References

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Appendix B

Excerpt from Metric Guide for Highway Publications — PennDOT

TABLE 1
LENGTH, AREA AND VOLUME CONVERSION FACTORS

QUANTITY	FROM ENGLISH UNITS	TO METRIC UNITS	MULTIPLY BY
Length	mile	km	1.609 344
	yard	m	0.9144
	foot	m	0.3048
	foot (US Survey)	m	0.304 800 61
	inch	mm	25.4
Area	square mile	km ²	2.590 00
	acre	m ²	4046.856
	acre	ha (10 000 m ²)	0.404 685 6
	square yard	m ²	0.836 127 36
	square foot	m ²	0.092 903 04
	square inch	mm ²	645.16
Volume	acre foot	m ³	1233.49
	cubic yard	m ³	0.764 555
	cubic foot	m ³	0.028 316 8
	cubic foot	L (1000 cm ³)	28.316 85
	100 board feet	m ³	0.235 974
	gallon	L (1000 cm ³)	3.785 41
	cubic inch	mm ³	16 387.064

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**TABLE 6
METRIC DESIGN ELEMENTS**

DESIGN ELEMENT	METRIC VALUE	ENGLISH VALUE	REMARKS
Design Speed*	30 km/h	18.64 mph	Running Speed = 30 km/h
	40 km/h	24.85 mph	Running Speed = 40 km/h
	50 km/h	31.07 mph	Running Speed = 47 km/h
	60 km/h	37.28 mph	Running Speed = 55 km/h
	70 km/h	43.50 mph	Running Speed = 63 km/h
	80 km/h	49.71 mph	Running Speed = 70 km/h
	90 km/h	55.92 mph	Running Speed = 77 km/h
	100 km/h	62.14 mph	Running Speed = 85 km/h
	110 km/h	68.35 mph	Running Speed = 91 km/h
	120 km/h	74.56 mph	Running Speed = 98 km/h
Lane Width	2.7 m	8.86 ft	1.56% less than 9' lane
	3.0 m	9.84 ft	1.60% less than 10' lane
	3.3 m	10.83 ft	1.55% less than 11' lane
	3.6 m	11.81 ft	1.58% less than 12' lane
	4.5 m	14.76 ft	1.60% less than 15' lane
Shoulder Width	0.6 m	1.97 ft	1.50% less than 2' lane
	1.2 m	3.94 ft	1.50% less than 4' lane
	1.8 m	5.91 ft	1.50% less than 6' lane
	2.4 m	7.87 ft	1.63% less than 8' lane
	3.0 m	9.84 ft	1.60% less than 10' lane
Vertical Clearance	4.45 m	14.60 ft	Includes 0.150 m for future resurfacing.
	5.05 m	16.57 ft	
Clear Zone	0.5 m	1.64 ft	Urban
	3.0 m	9.84 ft	Local/Collectors
	9.0 m	29.53 ft	Freeways
Curbs	150 mm	5.91 in	Mountable
	225 mm	8.86 in	Barrier
Pavement Cross Slope	2.0%	0.02 ft/ft	
	4.0%	0.04 ft/ft	
	6.0%	0.06 ft/ft	
	8.0%	0.08 ft/ft	
Stopping Sight Distance	1.070 m	3.51 ft	Eye Height
	0.150 m	5.91 in	Object Height
	0.610 m	2.00 ft	Headlight Height
Passing Sight Distance	1.070 m	3.51 ft	Eye Height
	1.300 m	4.27 ft	Object Height

* Low Speed Design = 60 km/h or less
High Speed Design = 80 km/h or more

TABLE 2
CIVIL AND STRUCTURAL ENGINEERING CONVERSION FACTORS¹

QUANTITY	FROM ENGLISH UNITS	TO METRIC UNITS	MULTIPLY BY
Mass	lb	kg	0.453 592
	kip (1000 lb)	tonne (1000 kg)	0.453 592
	ton (2000 lb)	tonne (1000 kg)	0.907 184
Mass/unit length	plf	kg/m	1.488 16
Mass/unit area	psf	kg/m ²	4.882 43
Density	pcf	kg/m ³	16.0185
Force	lb	N	4.448 22
	kip	kN	4.448 22
Force/unit length	plf	N/m	14.5939
	klf	kN/m	14.5939
Pressure, stress, modulus of elasticity	psf	Pa	47 8803
	ksf	kPa	47 8803
	psi	kPa	6.894 76
	ksi	MPa	6.894 76
Bending moment, torque, moment of force	ft-lb	N•m	1.355 82
	ft-kip	kN•m	1.355 82
Moment of mass	lb-ft	kg•m	0.138 255
Moment of inertia	lb-ft ²	kg•m ²	0.042 140 1
Second moment of area	in ⁴	mm ⁴	416 231
Section modulus	in ³	mm ³	16 387 064

**TABLE 7
MINIMUM RADIUS**

DESIGN SPEED (km/h)	MAXIMUM e	MAXIMUM f	TOTAL (e+f)	MINIMUM RADIUS (m)	ROUNDED MINIMUM RADIUS (m)
30	0.06	0.17	0.23	30.8	30
40	0.06	0.17	0.23	54.8	55
50	0.06	0.16	0.22	89.5	90
60	0.06	0.15	0.21	135.0	135
70	0.06	0.14	0.20	192.9	195
80	0.06	0.14	0.20	252.0	250
90	0.06	0.13	0.19	335.7	335
100	0.06	0.12	0.18	437.4	435
110	0.06	0.11	0.17	560.4	560
120	0.06	0.09	0.15	755.9	755
30	0.08	0.17	0.25	28.3	30
40	0.08	0.17	0.25	50.4	50
50	0.08	0.16	0.24	82.0	80
60	0.08	0.15	0.23	123.2	125
70	0.08	0.14	0.22	175.4	175
80	0.08	0.14	0.22	229.1	230
90	0.08	0.13	0.21	303.7	305
100	0.08	0.12	0.20	393.7	395
110	0.08	0.11	0.19	501.5	500
120	0.08	0.09	0.17	667.0	665

Reference: Design Manual, Part 2, Table 2.2.1.

For design values relating to other rates of maximum superelevation and associated minimum radius, refer to the AASHTO Green Book, Chapter III, Table III-6.

Note: e = Rate of superelevation (% × 0.01)
f = Side friction factor



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